UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/624,537	07/23/2003	Katsuhiro Horikawa	M1071.1855/P1855	6662

7590 08/09/2006

DICKSTEIN SHAPIRO MORIN & OSHINSKY LLP
Edward A. Meilman
41st Floor
1177 Avenue of the Americas
New York, NY 10036-2714

EXAMINER	
MAYES, MELVIN C	
ART UNIT	**PAPER NUMBER**
1734	

DATE MAILED: 08/09/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	10/624,537	HORIKAWA ET AL.
	Examiner	Art Unit
	Melvin Curtis Mayes	1734

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *18 May 2006*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,4-9,11-16 and 21-27* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,4-9,11-16 and 21-27* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

(1)

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

(2)

Claims 1, 4, 5, 7-9, 11 and 14-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Horikawa 6,080,328 in view of Ponomarev et al. 2004/0012000, Horikawa et al.6,383,408 and JP 2-122511.

Horikawa '328 discloses a method of making a piezoelectric ceramic element comprising: providing a piezoelectric ceramic of the formula $Pb_a[(Cr_xNb_{(1-x)})yZr_{(1-b-y)}Ti_b]O_3$, wherein $0.95 \leq a \leq 1.05$; producing green sheets; laminating green sheets with internal electrodes; and firing. Green sheets of thickness of 60-100 um can be coated with electrode paste of Ag/Pd of ratio 7/3 (col. 2, lines 39-67, col. 8, lines 5-35). Horikawa does not disclose limiting the Pb in the composition to molar quantity reduced by 0.5-5 mol% from that of stoichiometric composition or disclose firing (sintering) in an atmosphere of oxygen concentration of 5 vol% or less but more than 0 vol%.

Ponomarev et al. teach that to achieve high efficiency under dynamic operations such as in a multilayer piezoelectric ceramic transformer, low-loss hard piezoelectric ceramic materials are required [0002].

Horikawa et al. teach that a piezoelectric ceramic which has significantly low loss is a composition represented by the formula $Pb_x\{(Mn_aNb_b)_yTi_zZr_{(1-y-z)}\}O_3$,where on a molar basis

$0.95 \leq x \leq 0.995$ (col. 2,lines 44-56). When the amount of Pb is decreased below stoichiometric content, no foreign phase exist in the sintered material, and hence a piezoelectric ceramic having an even lower loss can be obtained (col. 3, lines 14-18)

JP 2-122511 (JP '511) teaches that a laminate of green sheets and Ag-Pd paste inner electrodes is calcined (sintered) in a low oxygen concentration environment of less than 50,000 ppm oxygen to improve reliability and reduce costs while retaining needed characteristics.

It would have been obvious to one of ordinary skill in the art to have modified the method of Horikawa '328 for making a piezoelectric ceramic element by limiting the limiting the Pb in the composition to molar quantity reduced by 0.5-5 mol% ($0.95 \leq a \leq 0.995$) from that of stoichiometric composition, as Horikawa et al. teach that such a composition has low loss because of Pb content decreased below stoichiometric content and as Ponomarev et al. teach that low loss is desired for multilayer piezoelectric ceramic elements. Limiting the Pb molar quantity as claimed would have been obvious to one of ordinary skill in the art to achieve lower loss, taught by Ponomarev et al. as desired for multilayer piezoelectric ceramic elements.

It would have been obvious to one of ordinary skill in the art to have further modified the method of Horikawa '328 by firing (sintering) the laminate in a low oxygen atmosphere of less than 50,000 ppm oxygen, as taught by JP '511, as used to sinter a laminate of green sheets and Ag-Pd electrodes to improve reliability and reduce costs while retaining needed characteristics. Sintering in an oxygen atmosphere of oxygen concentration in the range of up to 5 vol%, as claimed, would have been obvious to one of ordinary skill in the art as encompassed by the range of less than 50,000 ppm oxygen taught by JP '511.

By providing the piezoelectric ceramic of composition $Pb_a[(Cr_xNb_{(1-x)})yZr_{(1-b-y)}Ti_b]O_3$, the average valence of the B site component is greater than stoichiometric and greater than 4.000 but less than 4.100, as claimed and the B site component comprises Nb and Cr, as claimed in Claims 5, 7, 8 and 15.

(3)

Claims 6 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over the references as applied to claims 1 or 4, and further in view of Feltz et al. 2002/0098333.

Feltz et al. teach that in piezoelectric ceramic, partial substitution of the quadrivalent cations Zr and Ti on the B-positions can be by a combination of two-valent metal cations such as Ni and quinvalent metal cations such as Nb [0020].

It would have been obvious to one of ordinary skill in the art to have further provided Ni in addition to the Nb, as taught by Feltz et al., as metal cation that can be provided with Nb for partial substitution of Zr and Ti in piezoelectric ceramic. Providing Nb and Ni as part of the B-site component in partial substitution of Zr and Ti would have been obvious to one of ordinary skill in the art, as taught by Feltz et al.

(4)

Claims 12 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over the references as applied to claim 11, and further in view of JP 2001-181035.

Horikawa '328 discloses firing at a temperature of 1100°C or less.

JP '035 teaches that in making a piezoelectric ceramic transducer, etc, if the burning temperature is made low, it is possible to use cheaper silver-palladium alloy as the internal electrode. To lower manufacturing cost, it is desirable to make the percentage of palladium be

20% or less, which can be used with a burning temperature of 1000°C or less (computer translation [0004]).

It would have been obvious to one of ordinary skill in the art to have modified the method of the references as combined by coating the green sheets with Ag/Pd paste of at least 80% or 85% Ag, as taught by JP '035, to lower manufacturing costs by using cheaper Ag/Pd alloy. The use of an Ag/Pd paste of ratio of at least 80/20 or 85/15 would have been obvious to one of ordinary skill in the art to lower the manufacturing cost by using a cheaper Ag/Pd alloy.

By producing green sheets of thickness of 60-100 um, piezoelectric layers of thickness less than 64 um or 40 um after sintering are obviously provided.

(5)

Claims 22-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Horikawa 6,080,328 in view of Ponomarev et al. 2004/0012000, Horikawa et al.6,383,408 and JP 2-122511, further in view of either Ogawa et al. 6,280,650 or Takeshima 2001/0045792.

Horikawa '328 discloses a method of making a piezoelectric ceramic element comprising: providing a piezoelectric ceramic of the formula $Pb_a[(Cr_xNb_{(1-x)})yZr_{(1-b-y)}Ti_b]O_3$, wherein $0.95 \leq a \leq 1.05$; producing green sheets; laminating green sheets with internal electrodes; and firing. Green sheets of thickness of 60-100 um can be coated with electrode paste of Ag/Pd of ratio 7/3 (col. 2, lines 39-67, col. 8, lines 5-35). Horikawa does not disclose limiting the Pb in the composition to molar quantity reduced by 0.5-5 mol% from that of stoichiometric composition or disclose firing (sintering) in an atmosphere of oxygen concentration of 5 vol% or less but more than 0 vol%.

Ponomarev et al. teach that to achieve high efficiency under dynamic operations such as in a multilayer piezoelectric ceramic transformer, low-loss hard piezoelectric ceramic materials are required [0002].

Horikawa et al. teach that a piezoelectric ceramic which has significantly low loss is a composition represented by the formula $Pb_x\{(Mn_aNb_b)_yTi_zZr_{(1-y-z)}\}O_3$,where on a molar basis $0.95\leq x\leq 0.995$ (col. 2,lines 44-56). When the amount of Pb is decreased below stoichiometric content, no foreign phase exist in the sintered material, and hence a piezoelectric ceramic having an even lower loss can be obtained (col. 3, lines 14-18)

JP 2-122511 (JP '511) teaches that a laminate of green sheets and Ag-Pd paste inner electrodes is calcined (sintered) in a low oxygen concentration environment of less than 50,000 ppm oxygen to improve reliability and reduce costs while retaining needed characteristics.

Ogawa et al. and Takeshima each teach that one type of piezoelectric device formed using piezoelectric ceramic and electrodes is a piezoelectric buzzer (col. 1).

It would have been obvious to one of ordinary skill in the art to have modified the method of Horikawa '328 for making a piezoelectric ceramic element by limiting the limiting the Pb in the composition to molar quantity reduced by 0.5-5 mol% ($0.95\leq a\leq 0.995$) from that of stoichiometric composition, as Horikawa et al. teach that such a composition has low loss because of Pb content decreased below stoichiometric content and as Ponomarev et al. teach that low loss is desired for multilayer piezoelectric ceramic elements. Limiting the Pb molar quantity as claimed would have been obvious to one of ordinary skill in the art to achieve lower loss, taught by Ponomarev et al. as desired for multilayer piezoelectric ceramic elements.

It would have been obvious to one of ordinary skill in the art to have further modified the method of Horikawa '328 by firing (sintering) the laminate in a low oxygen atmosphere of less than 50,000 ppm oxygen, as taught by JP '511, as used to sinter a laminate of green sheets and Ag-Pd electrodes to improve reliability and reduce costs while retaining needed characteristics. Sintering in an oxygen atmosphere of oxygen concentration in the range of up to 5 vol%, as claimed, would have been obvious to one of ordinary skill in the art as encompassed by the range of less than 50,000 ppm oxygen taught by JP '511.

Using the method of the references as combined to make a piezoelectric element used as a piezoelectric buzzer (audio emitter part) would have been obvious to one of ordinary skill in the art, as taught by Ogawa et al. or Takeshima, as one type of piezoelectric device made using piezoelectric ceramic and electrodes.

By providing the piezoelectric ceramic of composition $Pb_a[(Cr_xNb_{(1-x)})yZr_{(1-b-y)}Ti_b]O_3$, the average valence of the B site component is greater than stoichiometric and greater than 4.000 but less than 4.100, as claimed and the B site component comprises Nb, as claimed in Claim 24.

(6)

Claim 27 is rejected under 35 U.S.C. 103(a) as being unpatentable over the references as applied to claim 22, and further in view of JP 2001-181035.

Horikawa '328 discloses firing at a temperature of 1100°C or less.

JP '035 teaches that in making a piezoelectric ceramic transducer, etc, if the burning temperature is made low, it is possible to use cheaper silver-palladium alloy as the internal electrode. To lower manufacturing cost, it is desirable to make the percentage of palladium be

20% or less, which can be used with a burning temperature of 1000°C or less (computer translation [0004]).

It would have been obvious to one of ordinary skill in the art to have modified the method of the references as combined by coating the green sheets with Ag/Pd paste of at least 80% or 85% Ag, as taught by JP '035, to lower manufacturing costs by using cheaper Ag/Pd alloy. The use of an Ag/Pd paste of ratio of at least 80/20 would have been obvious to one of ordinary skill in the art to lower the manufacturing cost by using a cheaper Ag/Pd alloy.

By producing green sheets of thickness of 60-100 um, piezoelectric layers of thickness less than 64 um after sintering are obviously provided.

Response to Arguments

(7)

Applicant's arguments filed May 18, 2006 have been fully considered but they are not persuasive.

Applicant argues that the present invention is based on the discovery of piezoelectric ceramic layers and internal electrodes can be sintered in an atmosphere of up to 5 volume percent oxygen without deteriorating piezoelectric constant when molar quantity of the A site component has been reduced and average valence of the B site component has been increased. Applicant argues that Horikawa '328 does not disclose altering stoichiometry, argues that Horikawa '408 relates to low loss piezoelectric ceramics and does not teach cofiring with internal electrodes in a reduced atmosphere, and argues that JP '511 relates to a ceramic that neither contains lead or is a

lead perovskite piezoelectric ceramic. Applicant refers to the Randall reference of record with respect to problems of co-firing piezoelectric ceramic with base metal electrodes.

(8)

Horikawa '328 disclose providing a piezoelectric ceramic of the formula $Pb_a[(Cr_xNb_{(1-x)})yZr_{(1-b-y)}Ti_b]O_3$, wherein $0.95 \leq a \leq 1.05$, thus disclosing using a composition in which the molar quantity of the A site component can be as low as 0.95 (reduced up to 5 mol%). Horikawa et al. '408 is pertinent because it suggests to limit Pb in the composition to molar quantity reduced by 0.5-5 mol% from that of stoichiometric composition so that no foreign phase exist in the sintered material, and hence a piezoelectric ceramic having an even lower loss can be obtained, low loss required to achieve high efficiency under dynamic operations, as suggested by Ponomarev et al. These teaching would have suggested to one of ordinary skill in the art to limit the molar quantity of Pb in the formula of Horikawa '328 to reduced by 0.5-5 mol% from that of stoichiometric composition for lower loss.

JP 2-122511 is pertinent because it suggests to sinter a laminate of green sheets and Ag-Pd paste inner electrodes is calcined (sintered) in a low oxygen concentration environment of less than 50,000 ppm oxygen to improve reliability and reduce costs while retaining needed characteristics. Applicants' arguments with respect to sintering atmosphere and the ceramic mentioned in JP '511 have been considered but are not persuasive. The Examiner takes the position that the teaching of JP '511 is also pertinent to co-firing piezoelectric ceramic with inner electrodes of Ag-Pd. With respect to the Randall reference, regardless of the method used by Randall to co-fire piezoelectric with base metal electrodes such as of copper, Randall et al. does not teach away from co-firing piezoelectric in a reducing atmosphere. Also see Watanabe et al.

6,221,271 which teaches sintering piezoelectric ceramic in atmosphere of oxygen concentration as low as 1%.

Conclusion

(9)

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

(10)

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Melvin Curtis Mayes whose telephone number is 571-272-1234. The examiner can normally be reached on Mon-Fri 7:30 AM - 4:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Chris Fiorilla can be reached on 571-272-1187. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Melvin Curtis Mayes
Primary Examiner
Art Unit 1734

MCM
August 7, 2006